Distribution Pattern of Phytoplankton Diversity and Abundance in Gadilam Estuary And Adjacent Mangroves, Southeast Coast of India

R.S. Sathishkumar[1], T. Ramesh[2], A. Sundaramanickam[3], K. Balachandar[4], R. Periyanayagi[5]
[1, 2, 3, 4] Dept of Marine Sciences
[5]Dept of Marine Zoology
[1, 2,3, 4]Annamalai University, Parangipettai 608 502, Tamilnadu, India
[5]Devanampattinam, Cuddalore 607 001, Tamilnadu, India

Abstract*- Many biotic and abiotic progressions furnish to changeability in phytoplankton diversity in aquatic and freshwater ecosystems. Literature about phytoplankton communities has been scanty in Gadilam Estuary. Totally, 90 species of phytoplankton belonging to seven taxa were identified at three different sampling stations during period of one year 2014-2015 in Gadilam Estuary. Among this assemblage, Bacillariophyceae (diatom) showed the highest distribution of the total abundance (Up to 52% at different zone of the study area). A concentration of chlorophyll 'a' was analyzed were ranged from (0.896 to 3.659 mg/m3) and it is a dependable mechanism for phytoplankton biomass. Phytoplankton scored their maximum population density during summer 2014 and minimum post monsoon 2015. To carry out statistical studies on phytoplankton species the Shannon & Wiener diversity index (H') maximum (5.175) species diversity was recorded in Devanampattinam (station 1) and the minimum (3.772) value was observed in Sonankuppam (station 2). Margalef's species richness (d'), Pielou species evenness (J') also analyzed. The K-dominance plot and Cluster analysis were used, to find out relationships between the different stations with seasons.*

Keywords- Phytoplankton, Bacillariophyceae, diversity, cluster analysis, Gadilam Estuary

I. INTRODUCTION

Mangrove forests are the dominating coastal ecosystems in tropical and subtropical regions where they cover from 60-75% of the coastline (Lalli& Parsons 1997). Mangroves are among the most productive and biologically diverse ecosystems in the world. Litter fall probably is the major sources of nutrient and energy supply to the aquatic phase of these systems (Nixon, 1980). They act as feeding and breeding ground for most of the marine organisms. Thus, planktonic communities and their periodic shift in abundance and composition is an important biotic factor in the mangrove ecosystem. Some studies on the annual distribution patterns of phytoplankton have been made earlier in the Pichavaram mangroves (Krishnamoorthy and Jayaseelan, 1983; Mani et al., 1986; Kannan and Vasantha, 1992; Mani, 1992; Kathiresan, 2000). Phytoplankton biomass increases due to eutrophication and causes uniform distribution in species composition. Simultaneously, opportunistic species start proliferating by dominating other (McQuatters-Gollop et al., 2009). The phytoplankton biomass chlorophyll 'a' (chl-a) is used as a good indicator of water quality and eutrophication because it provides good insights of that particular area (McQuatters-Gollop et al., 2009; Ninčević- Gladan et al., 2015).

Estuaries and mangrove ecosystem are playing a vital role in the Coastal fishery production. It is functioning as a shelter for most of the coastal populations. The diversity and distribution organism living in these ecosystem are influenced by the spatial and temporal coherence. Hence, in the present investigation we plan to study the diversity and seasonal variabilities of phytoplankton assemblages and analyze the composition of chlorophyll pigments from the Gadilam estuary and adjacent mangrove environment. The study elucidates the regulation of the variations in phytoplankton community through the multivariate analyses.

II. MATERIALS AND METHODS

Description of study area

The Gadilam Estuary connectingto the Bay of Bengal at Cuddalore(Lat:11°44' N; Long:79°46' E), Tamil Nadu, India(Fig.1).Three stations were selected for the present study. Of these, Devanampattinam (station 1) and Sonankuppam (station 2) were situated in the mangrove area and Cuddalore harbour (station 3), was situated without mangrove area. Sampling was carried out from summer 2014 to post-monsoon 2015.

Fig. 1. Map showing the study area

Sampling

Phytoplankton samples were collected from the surface waters of the study areas by towing a plankton net made of bolting silk (No.25 mesh size 48 µm) for half an hour. These samples were preserved in 2% neutralized formalin and analysed at laboratory.. For the quantitative analysis of phytoplankton, the settling method described by Sukhanovo (1978) was adopted. The phytoplankton was identified using the standard reference of Subramanyan (1946), Al-Kandari et al. (2009), Venkataraman (1939), Perumal et al. (1998), Santhanam et al. (1987) and Smith (1977) were followed. The surface water was collected for 1L in polypropylene bottle to analyzethe of chlorophyll ‘a’ by adapting the standard method of Strickland and Parsons (1972).

Statistical analysis

The phytoplankton cell abundance were carried out species diversity (H’), evenness (J’) and richness (D’) were calculated following the standard formulae (Shannon and Weaver, 1949; Pielou, 1966; Gleason, 1922) and other Multivariate techniques using the PRIMER 6.1.5 software package was used to detect distribution patterns of phytoplankton.

III. RESULTS AND DISCUSSION

Chlorophyll ‘a’ (chl-a)

Chlorophyll ‘a’ is considered as the mainly reliable and significant index of phytoplankton biomass. The chl-a values were ranged from (0.896 to 3.659 mg/m^3) (Fig. 2a). The maximum concentration was observed as during summer (2014) at St-1, the minimum concentration was found during post-monsoon (2015) at St-3. The recorded low post monsoonal values could be due to the influence of harbor activity, causing turbidity and less accessibility of light (Kawabata et al., 1993; Godhantaraman, 2002; ThillaiRajasekar et al., (2005) pointed out, maximum concentration of chl-a was observed during summer the due to sufficient UV radiation and suitable weather motivate to photosynthesis of primary producers its produce more amount of chl-a pigment on the water body, this statement was agreed by Prabhahar et al., 2011 and Sardessai et al., 2007.

Species and Percentage composition

The diversity of phytoplankton is mainly influenced by growth, propagation and quantification of that particular environment. Totally 90 species of phytoplankton were identified in the present study (Table 1) belonging to seven taxa Bacillariophyceae, Cyanophyceae, Dinophyceae, Chlorophyceae, Euglenophyceae, Trebouxiophyceae and Conjugatophyceae. The percentage wise distribution is presented in (Fig.2b). *Bacillaria paradaxa, Coscinodiscus concinnus, Coscinodiscus gigas, Coscinodiscus centralis, Ditylum brightwellii, Fragilaria oceanic, Fragilaria intermedia, Gyrosigma balticum, Lauderia annulata, Navicula clavata, Nitzschia longissima, Nitzschia sigma, Pleurosigma elongatum, Pleurosigma normanii, Rhizosolenia alata, Skeletonema costatum, Thalassionema nitzschioides, Thalassiothrix frauenfeldii* of Bacillariophyceae; *Anabaena constricta, Microcystis aeruginosa, Oscillatoria acuminate, Spirulina laxissima, Trichodesmium erythraeum, Phormidium favosum* of Cyanophyceae; *Ceratium extensum, Ceratium furca, Ceratium tripos, Dinophysis caudate, Noctiluca* sp., *Prorocentrum micans, Protoperidinium oceanicum* of Dinophyceae were observed most common taxa during the study period. The result was similar with others research indicating that Bacillariophyceae as the dominant genera on water sample (Xia et al., 2014, Batshi et al., 2012, Nassar and Gharib 2014, Bazin et al., 2014). The research explained that diatoms are usually the common element of epipelic communities (Moore 1974). It is well known that diatoms diversity are sensitive to a wide range of environmental variables, and that their community structure may quickly respond to changing physical, chemical and biological conditions in the environment (Mooser et al., 1996). Distribution of Bacillariophyceae species are known to be able to develop harmful algae blooms that increasingly affect aquaculture and tourism in wide areas of the subtropical (Philips et al., 2004).

Table 1: Distribution of Phytoplankton species in different stations at Gadilam estuary during 2014-2015.

Bacillariophyceae (Diatoms)	*Odontella mobiliensis*	*Phormidium sp.*
Amphiprora gigantea	*Pleurosigma angulatum*	**Dinophyceae (Dinoflagellates)**
Anomoneis sp.	*Pleurosigma elongatum*	*Ceratium extensum*
Asterionellopsis glacialis	*Pleurosigma normanii*	*Ceratium furca*
Bacillaria paradaxa	*Planktoniella sol*	*Ceratium tripos*
Bellerochea malleus	*Rhaphoneis* sp.	*Dinophysis caudata*
Bacteriastrum delicatulum	*Rhizosolenia alata*	*Dinophysis tripos*
Biddulphia mobiliensis	*Rhizosolenia robusta*	*Noctiluca scintillans*
Chaetoceros affinis	*Skeletonema costatum*	*Noctiluca sp.*
Chaetoceros curvisetus	*Synedra sp.*	*Pyrophacus steinii*
Coscinodiscus concinnus	*Thalassiosira subtilis*	*Pyrophacus sp.*
Coscinodiscus gigas	*Thalassionema nitzschioides*	*Prorocentrum micans*
Coscinodiscus centralis	*Thalassiothrix frauenfeldii*	*Prorocentrum sp.*
Coscinodiscus marginatus	*Triceratium reticulatum*	*Protoperidinium depressum*
Coscinodiscus lineatus	**Cyanophyceae (Blue-Greens)**	*Protoperidinium oceanicum*
Coscinodiscus radiatus	*Anabaena constricta*	**Chlorophyceae (Greens)**
Diploneis sp.	*Anabaena doliolum*	*Chlorococcum humicola*
Ditylum brightwellii	*Aphanocapsa grevillei*	*Microsphora willeana*
Ditylum sol	*Aphanocapsa sp.*	*Coelastrum sp.*
Fragilaria oceanica	*Merismopedia* sp.	**Euglenophyceae**
Fragilaria intermedia	*Microcystis aeruginosa*	*Euglena sp.*
Guinardia flaccida	*Microcystis sp.*	*Phacus acuminatus*
Gyrosigma balticum	*Oscillatoria acuminata*	*Phacus longicauda*
Hemidiscus hardmanianus	*Oscillatoria limosa*	**Trebouxiophyceae**
Hemidiscus sp.	*Oscillatoria margaritifera*	*Closteriopsis longissima*
Lauderia annulata	*Spirulina laxissima*	*Chlorella marina*
Leptocylindrus danicus	*Spirulina meneghiniana*	*Chlorella vulgaris*
Leptocylindrus sp.	*Synechococcus elongatus*	**Conjugatophyceae**
Melosira sp.	*Synechocystis salina*	*Spirogyra indica*
Navicula clavata	*Trichodesmium erythraeum*	
Navicula sp.	*Trichodesmium* sp.	
Nitzschia seriata	*Coelosphaerium dubium*	
Nitzschia longissima	*Gomphosphaeria sp.*	
Nitzschia sigma	*Phormidium favosum*	

Population density

Seasonalvariations in phytoplankton was distinguished as different stations. The minimum density of phytoplankton observed at St-3 (1.320×10^4cells L^{-1}) during post-monsoon 2015 and maximum was noticed at St-1 (4.858×10^4 cells L^{-1}) during summer 2014 are shown in (Fig.2c). The abundance of phytoplankton was lowest during pre-monsoon and monsoon seasons. The major reason attributed for the low density during these seasons are heavy rainfall, high turbidity caused by run-off, reduced salinity, decreased temperature and pH, overcast sky and cool conditions (Vasantha 1989, Anbazhagan 1988,Ananthan et al., 2012). The high density was observed during summer due to more stable hydrographical parameters (Babu et al., 2013, Gieskes and Kraay 1984).

Diversity indices

A spatial variation of phytoplankton species diversity index (H') ranged from 3.772 to 5.175 is illustrated in (Fig. 2d). The minimum diversity was observed at St-2 during monsoon (2014) the maximum diversity was observed during post monsoon (2015) at St-1. The spatial variation of phytoplankton species richness (D') ranged from 8.461 to 3.526 is presented in (Fig. 2e). The highest values ware observed during post monsoon (2015) at St-1 and the least values were found during monsoon (2014) at St-2. The spatial variation of Pielou's Evenness index (J') was ranged from 0.871 to 0.993 is illustrated in (Fig. 2f). The maximum values ware observed during pre-monsoon (2014) at St-2 and the minimum values were observed during monsoon (2014) at St-3. The increase in numerical density indicates the species abundance in a particular region (Chandran 1985). The fewer amounts of index values strength is indicate to lack of species richness (Arumugam et al., 2016). The high value of diversity index commonly implies healthy ecosystem, even as a low value indicates adorned condition (Manna et al., 2010). The nature of species diversity in relation to species composition and phytoplankton density is a notable feature in any aquatic ecosystem (Chandran, 1985). The least values of diversity indices were recorded during monsoon season and maximum were recorded during post monsoon season, similar observation was proved that Arumugam et al., 2016 at muthupettai region south east coast of India.

Cluster analysis

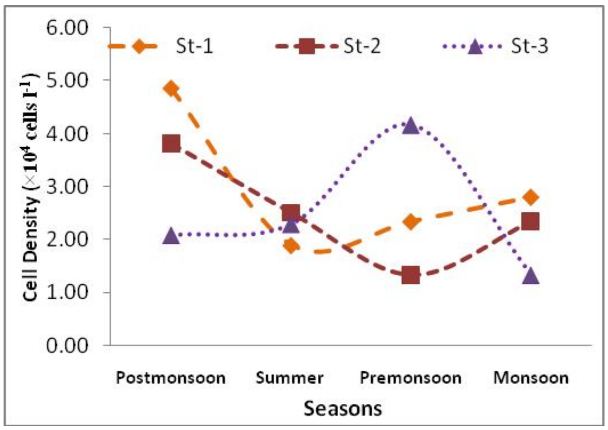
In the present study, the cluster analysis was carried out the percentage of similarity between three different stations of Gadilum estuary. The dendrogram wan for the current study exposed that samples with area combine nature got grouped individually indicating variation in species composition presented in (Fig. 3a). The sampling station of St-1 and St-2 formed the major group followed by St-3 were linked together and separate. Samples lying closer have more similarity while samples lying far apart have more dissimilarity in species composition and abundance. This similarity group was link to the presence of mangrove stations, the variation in species composition and abundance in the stations studied. True to the above said fact as evidence we have the earlier reports (Rajasegar et al., 2000; Gowda et al., 2001; Senthilkumar et al., 2002).

Species Abundance (Dominance Curve)

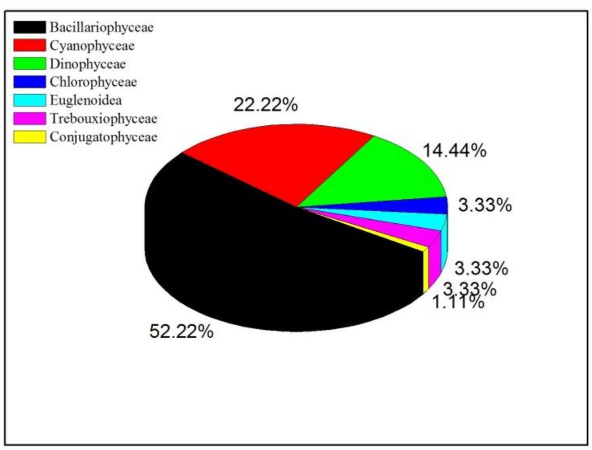
The dominance curve for the different stations is depicted in (Fig. 3b). Which depict exhibited higher dominance and lower diversity, the *k*-Dominance curves of Stations were almost similar or overlapping except St-3. The cumulative dominance of the St-1 and 2 reached simultaneously cumulative 98%. According to Clarke and Warwick (2001), k-dominance curves are cumulative ranked abundance, plotted against species rank or log transformed species rank. The elevated curve of St-3 considered having the lowest diversity. The low species diversity observed at St-3 might be due to higher dominance of some phytoplankton species.

IV. CONCLUSIONS

This present investigation obviously explained the Phytoplankton diversity, abundance value are influenced by estuarine and harbor regions. This study provides baseline information of the phytoplankton distribution and abundance along the Gadilam estuary. Further, investigation is needed to assess the influence of environmental and anthropogenic activity in relation to the phytoplankton distribution.



A



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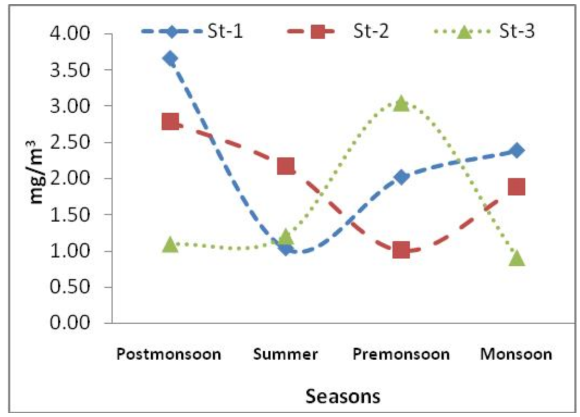

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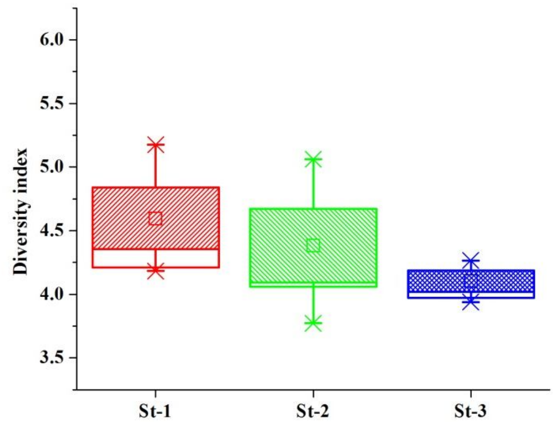

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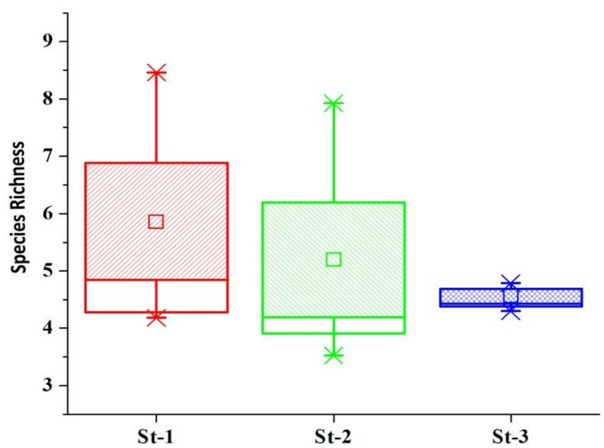

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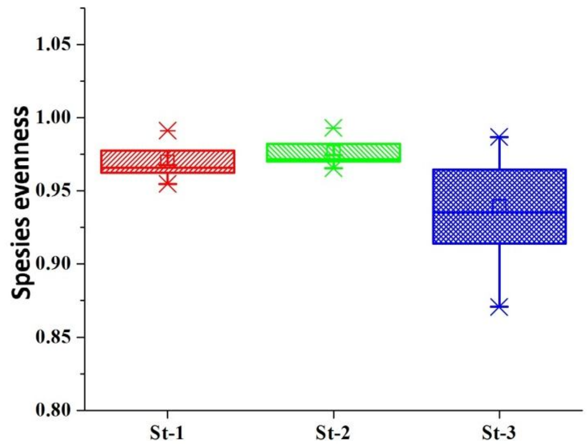
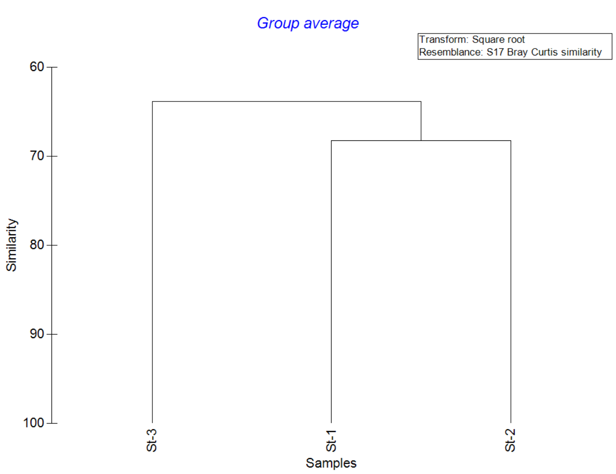


F

Fig.2. Seasonal trends of Chlorophyll ‘a’ concentration (a), Percentage composition of phytoplankton distribution (b), Population density of phytoplankton communities in different zones of Gadilam estuary (c), Box plot shows the phytoplankton species diversity index (d), Species richness (e) and Species evenness (f).



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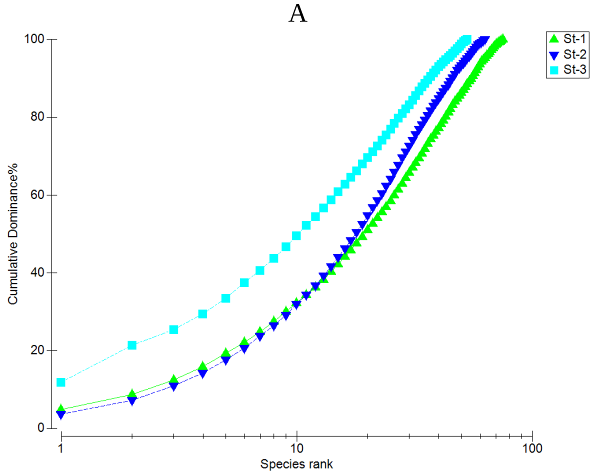

B

Fig.3. Dendrogram showing similarity for the different sampling stations (a), Diversity pattern of K- dominance curves in all sampling stations (b).

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